Airborne, All The Way, 3D From the Sky

Approach for an Air Drop Capable, Medium Tactical Vehicle

CPT Peter F. Syverson, USA

In warfighting today, the U.S. military rolls into combat with heavily armored vehicles capable of protecting their occupants from large and highly lethal improvised explosive device (IED) blasts. Given that threat, it would seem surprising that our forces still require unarmored vehicles for combat missions.

Product Manager Medium Tactical Vehicle (PM MTV) fields three models of unarmored vehicles: the Airborne's MTV Low Velocity Air Drop (LVAD) M1081, M1093, and M1094 (2.5T Cargo, 5T Cargo, and 5T Dump respectively). These models were designed in the early 1990s to provide low-tech solutions to an Airborne requirement. Sustainment and production problems have arisen for the LVAD fleet in recent years. The largest problem to overcome is the obsolescence of the LVAD cabs. Replacement parts are nonexistent in many cases, and contractors are unwilling to produce the small quantities required by the Army to sustain the fleet.

Given the lack of replacement cabs or parts, PM MTV has discovered that old LVADs are potentially coded out due to the unavailability of a door panel that costs a few hundred dollars, even though the rest of the truck is operational. When the cab shell was last built in 2008, it was proprietary to the contractor that manufactured it. At the time, the government did not purchase the Technical Data Package (TDP) or the dies used to stamp out the cab. The dies have since been sold off, highly modified and consequently destroyed. A TDP is necessary in order for PM MTV to build cabs or replacement panels. A reverse engineering project began in 2012 to build a TDP in conjunction with current prime contractor. The cost was well more than $6 million to validate this TDP, build the 29 tooling stamps required for all the body panels, and produce five prototype cabs. It would take more than 450 days after award to produce the five prototype cabs (remember these numbers). For a niche population of airborne trucks with no new production on the horizon, the price killed the project.

But within three years, units in the field wonder why they cannot acquire a cab part from the Defense Logistics Agency (DLA). The PM and DLA now face the same dilemma they faced a few years earlier. Trying to think outside the box for a low-cost solution to TDP validation and prototyping, on a small budget and with a short timeline, I remembered reading about the Navy's research in constructing 3D buildings.

Syverson *is the Assistant Product Manager for Medium Tactical Vehicle at Tank-automotive and Armaments Command (TACOM). He graduated and was commissioned from Northern Illinois University and has an Industrial Technology Degree. His previous assignments included 4th Brigade Combat Team, 82nd Airborne Division as Commander of both A Troop, 4-73 Cavalry (Airborne) and Headquarter and Headquarters Company, 1-508th Parachute Infantry Regiment. He earlier was a Reconnaissance, Surveillance and Target Acquisition Platoon Leader with 5-1 Cavalry Regiment, 1/25 Infantry Division.*

Low Velocity Air Drop rigged at Fort Bragg Heavy Drop Rig Site in North Carolina.
Photo by the Army Product Management Office for Medium Tactical Vehicles.

I thought if the Department of Defense (DoD) can print in that size in concrete, why not a 6x4-foot truck cab? With the Detroit Auto Show in town, I read about a company called Local Motors that printed a 3D car and would exhibit both its car and Local Motors' additive manufacturing technology at the show. I decided to make the Detroit Auto Show my place of duty in order to research the feasibility of using additive manufacturing to build a 3D composite cab.

At the show, I was impressed with Local Motors' Strati 3D car and impressed again with the technology partner's exhibit. Oak Ridge National Laboratory (ORNL) was showcasing its 3D printed Shelby Cobra next to Local Motors, and all the minds behind the project were present to answer questions. Located conveniently across from the ORNL exhibit was the Tank-automotive and Armaments Command (TACOM) exhibit featuring an autonomous legacy MTV with an unarmored cab. As I spoke with the ORNL people who had developed the 3D Cobra, I pointed to our MTV and asked if it was feasible to print the shell of the cab. To my delight, the short answer was "Yes."

Oak Ridge National Laboratory is at the leading edge of large-scale additive manufacturing and produces at speeds and sizes that make printing a high-strength LVAD cab very feasible. The lead PM MTV LVAD engineer, Jason Zebrowski, and I decided to take a trip to visit ORNL in Knoxville, Tennessee. Our idea was to produce a 3D composite prototype cab that looks and functions the same as the old. Ideally, PM MTV will achieve a validated TDP and manufacturing method that requires no tooling and no production line and that has the ability to build affordable, low volumes of new cabs and replacement parts to keep the legacy trucks in the field. Since our visit, the research staff at ORNL has agreed to prototype our cab, starting with the most complex part—a complete door assembly. If the door proves to be feasible and functions properly on an existing LVAD cab, PM MTV will move forward with the prototype of the whole cab. With the assistance of the DoD Manufacturing Technology Program, all this will happen for less than $100,000 and within a few weeks of the project's start. Compared to the $6 million and more than 450 days for the conventional manufacturing method, 3D may end up being the better buy.

Although this information is not new to some, I wanted to discuss the many potential benefits of additive manufacturing to both the Army and the PM when looking at the LVAD. As we look at cost as our largest consideration in a physically constrained environment, we look first and foremost at the departure from the traditional manufacturing process. As mentioned, 29 stamps are required to make the current panels that comprise the LVAD. These stamps, in 2012 dollars, cost more than $4 million and required 6 months just to manufacture. Stamps also require large machines or fixtures to function, in addition to an assembly line that requires time to set up and calibrate. By shifting to an additive manufacturing process, we fundamentally shift away from tooling and set-up time. Theoretically, a company like Local Motors can build their Strati today, and, by tomorrow, with a TDP and 3D models, produce LVAD cabs on the same manufacturing floor. That concept is revolutionary, given how the automotive industry traditionally builds vehicles.

The PM would never reach thousands of units of production for LVAD, and we do not want to do so. Low volume is our goal, and our dilemma. Industry and the Army do not want to produce a few hundred anything, especially something as complex as a vehicle cab. Due to the time and effort required, low production runs leave little profit for industry and huge costs to the customer (although, for deep enough pockets, this dilemma does not apply). With additive manufacturing, we sidestep the issue. Given a total fleet of 2,200 vehicles, PM MTV would produce only about 900 vehicles

(maximum) to replace the obsolete 20-year-old nitial (A0) imodels and a limited run of replacement parts for the A1R models remaining in the fleet over the next 5 years.

Continuing to take cost into consideration, PM MTV has looked at the materials used in additive manufacturing. At $2.40 to $5.00 per pound, the composites and thermoplastics utilized today become very attractive when analyzing our current, 800-pound metal LVAD cab. As we explored these composites, MTV discovered that they also are largely—up to 80 percent—recyclable. Recyclable material can have huge implications, if the Army ever invests in 3D printers in its depot-level maintenance facilities. Imagine a scenario in which an LVAD comes into maintenance with a damaged door and requires a new one. The chief maintenance officer takes off the door, strips it, throws the door through the shredder, then in short order prints a new one for the paratrooper, using the same material as the old. All the maintenance officer needs is a 3D printer and the 3D-model computer-aided design (CAD) data from DLA.

I also have been asked why PM MTV is pursuing the same LVAD cab design. The answer is that PM MTV wants to maintain all the current National Stock Numbers and part numbers that make up the rest of the cab (seats, steering columns, hinges, etc.) and avoid spending the time and money on engineering new when parts already exist. By doing so, we can create a new stock of replacement panels for the LVADs still in service, reduce logistic footprints and save money by not reinventing a truck that has a limited production quantity.

Performance is the biggest question PM MTV has for our prototype. While we believe ORNL will produce a composite cab that looks and functions like our legacy sheet-metal cab, we will need to conduct static and live drop testing from an aircraft to determine if it will pass test requirements. With that said, there are promising prospects that we will succeed, given our options of composites with varying strengths and mechanical properties. These properties will have added benefits that are not possible for the current metal cabs. For instance, LVADs are exempt from current MTV armor requirements, due to weight and the nature of the Airborne's mission, but the LVAD may reach a level of ballistic protection not seen in the legacy cabs—depending on the composite we choose and internal design structure of the panels.

Additionally, a persistent problem in the legacy LVAD fleet is corrosion of the earlier A0 models. Once a cab is damaged and the bare metal exposed, corrosion rapidly sets in if not checked by corrective painting or part replacement. A plastic composite cab will help reduce the DoD's expenditures on corrosion prevention programs and use of the ever time-consuming and difficult Chemical Agent Resistent Coating paint. Depending on the plastic composite chosen for the LVAD, we may even avoid painting altogether. Some plastics are translucent, which allows the adding of color pellets to achieve olive drab or tan paint schemes.

As I spoke with the ORNL people who had developed the 3D Cobra, I pointed to our MTV and asked if it was feasible to print the shell of the cab. To my delight, the short answer was "Yes."

The schedule of this ambitious project has raised some eyebrows, and we understand why. To counter the skepticism, I would have to say you need to see ORNL's additive printing process in action. As you discover where 3D printing is today and begin to understand the process, you gain an appreciation for how quickly a prototype can develop and move to production. While at ORNL, Zebrowski and I witnessed an exchange between two engineers deliberating why a design of theirs had printed poorly. In a 20-second exchange, they decided to modify the design on the CAD model and print another one. That is two prototypes and one design change created in a single day—and, for the complexity of the part, it was quite impressive. Knowing how fast the staff there move, ORNL thinks they can create the whole LVAD cab in a 2- to 3-week timeline. This includes consideration of design errors and reprints for incorporation in a final validated TDP.

That is why PM MTV hopes to have the cab prototype in hand by summer and a completed truck assembled by the end of 2015 to take to test in 2016. Is it ambitious? Absolutely. But with additive manufacturing, such a timeline becomes feasible, and working with limited resources under short time constraints is what (former) paratroopers do. PM MTV and I are up for the challenge and look forward to providing an update in the near future.

The author can be contacted at **peter.f.syverson.mil@mail.mil**.